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Migration of some polluting substances to the soils and underground waters of territories adjacent to the lower reach of Natanebi River (Western Georgia)

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Annotation

In order to determinate migration of some polluting substances to the soils and underground waters of the territory adjacent to Natanebi River, located in the Black Sea coastal area of the western Georgia, there has been studied soil and ground water pollution with different metals in the Tsvermaghala-Natanebi agrogenic region of the Black Sea coastal territory of Georgia. As a result of research, it has been established that the ground waters hold prominent place in heavy metals migration and are in direct relation with relief slope and underground water movement.

Key words: heavy metals, migration, ground waters

Introduction

The Black Sea coastal territory of Georgia is especially valuable due to its natural conditions and from economic viewpoint. That is why an assessment of its ecological state is so relevant. Among multiplicity of environmental pollution factors, heavy metal pollution of soils and natural waters is of particular importance. Therefore, a study of migration of heavy metal total and moving forms is of great importance.

Microelements and heavy metals are represented in different quantities in the natural waters. Their penetration depends on natural or anthropogenic factors. Chemical exhaustion of rocks and soil formation are among the basic natural processes, under influence of which microelements hit the water. Both of these processes are substantially controlled by biological and microbiological factors. Anthropogenic focuses of microelements' accumulation in water are as follows: mineral resource survey and extraction, agriculture, industrial and communal (domestic) sewage waters. Water pollution with microelements is a very important factor, since it has a strong effect on total geochemical turnover of chemical elements and on geo-ecological state of the environment.

Rapid urbanization and motor highway construction have led to increase of surfaces impervious to water, while climate changes have stipulated high intensity of precipitations, as a result of which both increased peaks of hydrography and growing concentration of typical pollutants are in evidence. Atmospheric precipitations and motor car emission should be mentioned among polluting factors in the area under study, as well.

Research object and methodology

The area under study included the Black Sea coastal territories, in particular, the zones with 20-70 m altitudes above sea level, northerly adjacent to Natanebi River. There are represented the subtropical podzolic, sod-podzolic and alluvial soil types of the southern part of Kolkheti lowland (Guria-Achara) and silt-boggy soils (glei soils) prevail here. Fertile alluvial soils are present here in the form of a narrow band along the Natanebi River, as well. Black earth (humus)-containing soils are in moderate quantity here, as well as a content of hygroscopic waters. The specific weight is within the range of 1.24-1.41. Hydrolytic nitrogen content is registered in average or small quantities. Soils here are rich in phosphorus and poor in exchange potassium. Radionuclide pollution is frequently observed, as well. Silt-podzolic soils are peculiar for the elevated part of Kolkheti lowland. In Grigoleti, Maltakva and northwards peaty boggy soils are found. Northward and southward to Supsa delta, in narrow band along the coast there are represented cespitose-sandy soils. Alluvial soils prevail at the river-bed terraces. All the above-mentioned soils are saturated with water or water-logged at the even lands.

The area under study belongs to the Black Sea humid subtropical climatic region of the western Georgia, which is characterized by moist climate, warm and snowless winter and hot summer. The average years-long temperature of January is 5-6°C, air temperature maximum is very high, 40-41°C and is mainly registered in July, while average temperatures are high in August.

Multiyear total amount of atmospheric precipitations varies from 2000 mm to 2500 mm. According to seasons the most abundant precipitations fall on autumn, while the least abundant – on spring. Daily precipitation maximums vary from 227 mm (Ureki) to 260 mm (Supsa). The seasonal nature of winds is clearly expressed here. The summer wind regime, when winds come from the Sea, starts in April and lasts until October. In case of winter wind regime wind blows from the land from November to March.

According to the pattern of hydrogeological zoning of the territory of Georgia, the mentioned area enters the western part of Kolkheti artesian basin. It is characterized by aquiferous stratum of alluvial precipitations of flood-plain and above flood-plain terraces. It is extended over Choloki, Natanebi and Sepa rivers valleys and water- bearing deposits are represented by boulder-pebble stone, gravel, sands, clays, and interlayers of sandy and loamy soils. Water-bearing deposits thickness (depth) is up to 30 meters and it is nonpressure. Seasonal amplitude reaches 3.0 meters, horizon waters are connected with surface waters. These waters are fresh, hydrocarbonate, magnesium-calcium, somewhere sodium-calcium, with 0.1-0.5 g/l mineralization. Horizon is featured by high water content, especially in the Natanebi river valley. Horizon is nourished at the expense of atmospheric precipitations, as well as surface waters and unloading of water-containing complexes available under horizon. These waters are used for drinking. The ground-water table (aquifer) is located at 0.5-2.0 meters depth from the Earth ground. High level of ground waters is observed in lacustrine and boggy deposits, which are developed in the central and western parts of the Kolkheti lowland. Ground waters of this aquiferous stratum are characterized by water table insignificant inclination westward (0.005-0.007), which is one of the reasons of water-logging at these territories.

In order to determine heavy metal migration to the underground waters of the area under study, complete soil cuttings have been made at several territories of Tsvermaghala-Natanebi agrogenic region and analysis of soil and ground waters of adjacent territories has been conducted.

Main works have been executed close to no.4, 5, 6, 7 cuts.

Cut P4, located at 70 m above sea level, cut depth 3 m, red soil is moderately polluted with lead, nickel concentration is low, while copper concentration is increased.

Cut P5, located at 60 m above sea level, cut depth 3 m, includes red soils, which are moderately polluted with cobalt, nickel and copper.

Cut P6, 35 m above sea level, cut depth 3 m, is represented by sod-podzolic and virgin soils, cobalt and nickel concentrations are average here, while copper concentration is increased.

Cut P7, 20 m above sea level, cut depth 3 m, is represented by sod-podzolic soils, zinc concentration is average, nickel and copper concentrations are increased.

Based on our research goal, we have determined Pb, Zn, Co, and Ni concentrations in the collected samples (see Table no. 1). As is seen from the obtained data, heavy metals number is insignificant, though is obviously featured by growing trend in the direction of relief slope. For instance, in Cut no. 4 (red soils) lead concentration is 0.001 mg/l (MPC – 0.01 mg/l), but when going downhill (to the Sea) in the direction of relief slope, the same lead content in Cut no. 5 has increased up to 0.007 mg/l, then has reached 0.008 mg/l in Cut no. 6 (sod-podzolic soils) and 0.009 mg/l in Cut no. 7 (sod-podzolic soils). Almost all soil cuts are characterized by slight but nevertheless increased concentration.

Table 1. Heavy metal concentrations in soil cuts

MPC	*Pb*	*Zn*	*Co*	*Ni*	*Cu*
Cut	0.01 mg/l	3 mg/l	0.1 mg/l	0.05 mg/l	2 mg/l
P4	0.001	0.010	0.02	0.009	0.100
P5	0.007	0.050	0.07	0.010	0.500
P6	0.007	0.180	0.08	0.020	0.800
P7	0.090	1.000	0.09	0.040	1.000

Conclusion

Some polygons are located in such places, where there are no agricultural lands and such concentration of heavy metals should not take place. It is a testament to the fact that there are active heavy metal migration processes in the direction of relief slope. Toxic chemical elements first of all hit the soil surface from the environment, and further as a result of erosion, leaching out and penetration into deep soil layers the processes of their geochemical accumulation and migration take place. Due to this fact the soils of territories adjacent to Black Sea under current conditions may transform into a powerful source of ground waters, rivers and even Black Sea pollution.

Heavy metals experience migration to the ground waters in the direction of the relief slope that is why special attention has to be paid to further investigations in this region in order to get a complete retrospective picture and get rid of soil and ground water pollution, since the ground waters are directly connected with the Black Sea water area.

Thus, the very interesting outcome has been obtained resulting from our research, in particular, ground water of Tsvermaghala-Natanebi agrogenic region play an essential role in heavy metals migration towards the relief slope.

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